Run IIb Trigger Simulation

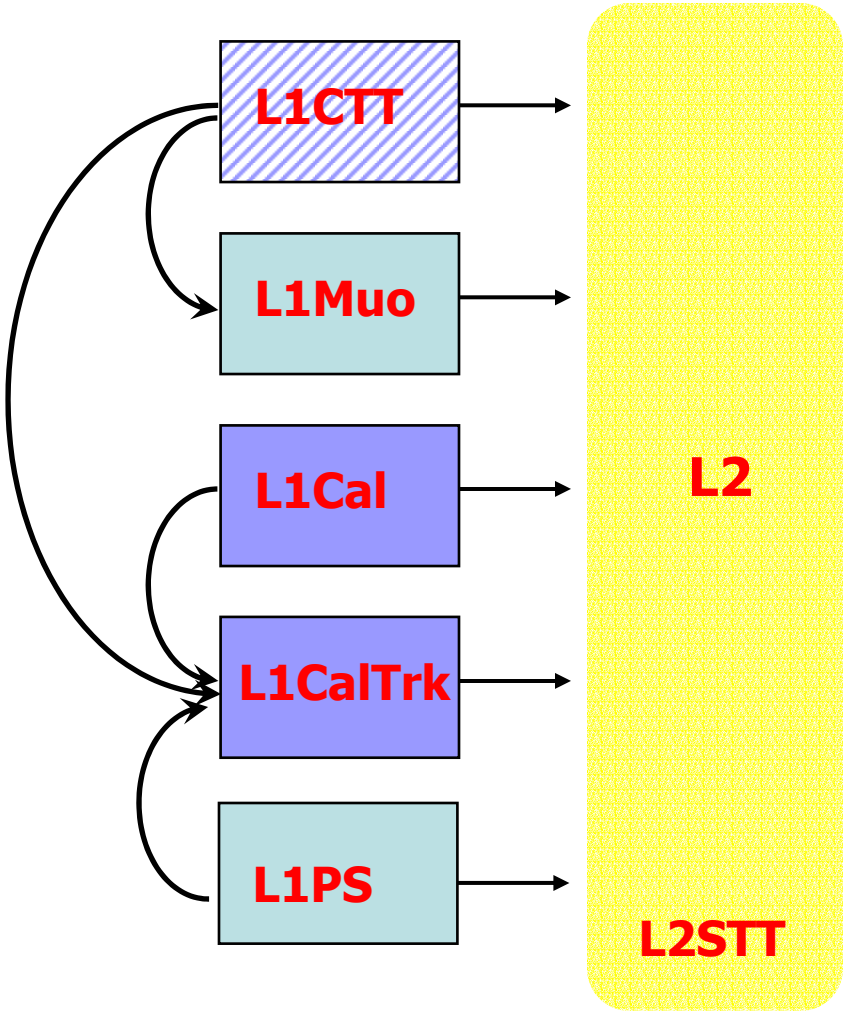
Emanuela Barberis

Northeastern University

Director's Review 2/3/2005

- **DØ Trigger Simulation software :IIb components**
- **Auxiliary tools**
- **Optimization of L1 Cal algorithms**
- **Trigger menu studies**
- **Simulation manpower**

DØ Trigger simulation software



Upgraded IIb software components:

- new
- new IIa (and IIb) design
- unchanged

Standalone versions of L1CTT&L1Cal simulators used in TDR trigger studies and algorithm optimization.

L2STT simulator updates tied to Silicon Layer Ø software.

L1CTT Simulator

New design and code for IIa (with easy extension to IIb, via new equation sets).
Scope: hardware emulation & monitoring, efficiency and rate calculations.
CVS software package name: **tsim_l1ctt**.
Contact: Carsten Hensel, University of Kansas.

“ *The **L1CTT** simulator reads data (or MC) and applies the predetermined track templates to the hits in the 80 CFT trigger sectors. It subsequently emulates the track collection sorting and output features of the L1CTT hardware.*
It outputs found tracks to L1Muo, L1CalTrack, and the L2STT, as well as the L1 trigger framework **”**

L1CTT Simulator

Status:

- First version of the IIa code available and integrated in the overall trigger simulator executable.
- Working to add all trigger terms and IIb compatibility.
- One additional university group (UTSC) signed up to extensively compare old/new code and IIa/IIb versions.

L1Cal Simulator

Scope: objects definition and optimization, efficiency and rate calculations.
Benchmarked against emulation code for sliding window algorithm.
CVS software package name: **tsim_l1cal2b**.
Contact: Wendy Taylor, York University.

“ *The **L1Cal** simulator reads data (or MC) and simulates its treatment by the Analog to Digital and Filter card (**ADF**). It subsequently simulates the Trigger Algorithm Board (**TAB**), by defining jet, electron or tau triggers. It also simulates the Global Algorithm Board (**GAB**), by defining global and topological triggers. It can output to a root-tuple* **”**

L1Cal Simulator

Status:

- Used extensively in its stand-alone version.
- First version integrated in the overall trigger simulator executable.
- Algorithms defined.
- Passing information to L1CalTrack.
- Working on passing information to L2.

L1CalTrack Simulator

Scope: hardware emulation & monitoring, efficiency and rate calculations.
CVS software package name: **tsim_l1caltrack**.
Contact: Ken Johns and Charlie Armijo, University of Arizona.

“ *The **L1CalTrack** simulator takes the L1CTT, L1Cal, L1PS inputs (data or MC) and mimics the electronics cards MTM, MTCxx, and MTCM. It defines electron, tau, and jet triggers. It can output to a root-tuple*”

L1CalTrack Simulator

Status:

- First version integrated in the overall trigger simulator executable.
- Passing information to L2.
- Working on processing information from L1Cal and defining algorithms.

Auxiliary tools: Trigger Rate Tool

Not part of the original IIb simulation scope, but proven to be very effective in IIa trigger list studies (e.g. design of the current IIa v13 trigger list).
Scope: estimate rates and overlaps for the development of physics trigger lists.
CVS software package name: **trigger_rate_tool** (and **l1cal2b_sliding_windows**).
Contact: Sabine Lammers, Columbia University.

"*The **Trigger Rate Tool** is used to estimate (and extrapolate) trigger rates in data. It allows the computation of the rates and overlaps of individual as well as sets of triggers. The tool thus provides excellent predictive capabilities for the trigger rates at all levels for large and complicated global trigger lists* **"**

Auxiliary tools: Trigger Rate Tool

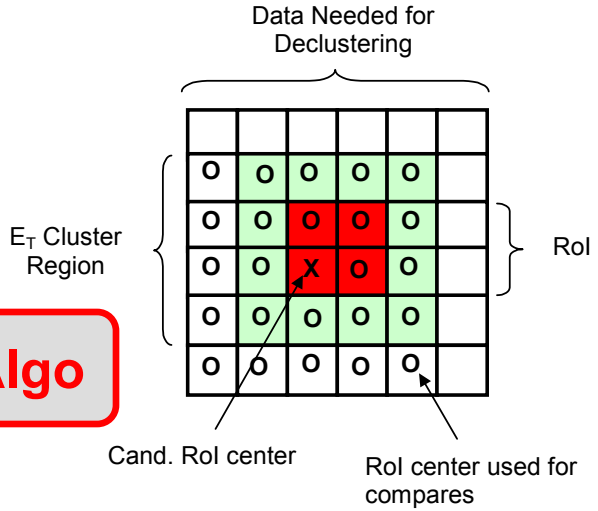
Status:

- Running.
- Final version of L1Cal electron and jet algorithms implemented.
- Extensively cross-checked against tsim_l1cal2b.
- Used for trigger list studies.
- The library of sliding windows algorithms (l1cal2b_sliding_windows) is also used for data verification.
- Working on implementing tau terms and L1CalTrack algorithms.
- Working in using the tool on MC, to estimate event efficiencies.

Optimization of L1 Cal objects

L1Cal Electron, Jet, Tau objects have been defined and optimized using **tsim_l1cal2b**. The electron algorithm was recently re-optimized using IIa L2 experience (results follow).

Jet Algo



Tau Algo

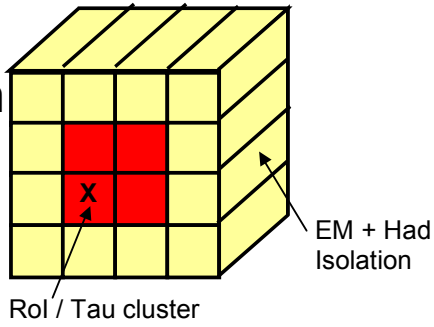
Jet&Tau Algo's:

2,1,1

E_T/Isolation region

Separation

Region of Interest (RoI)



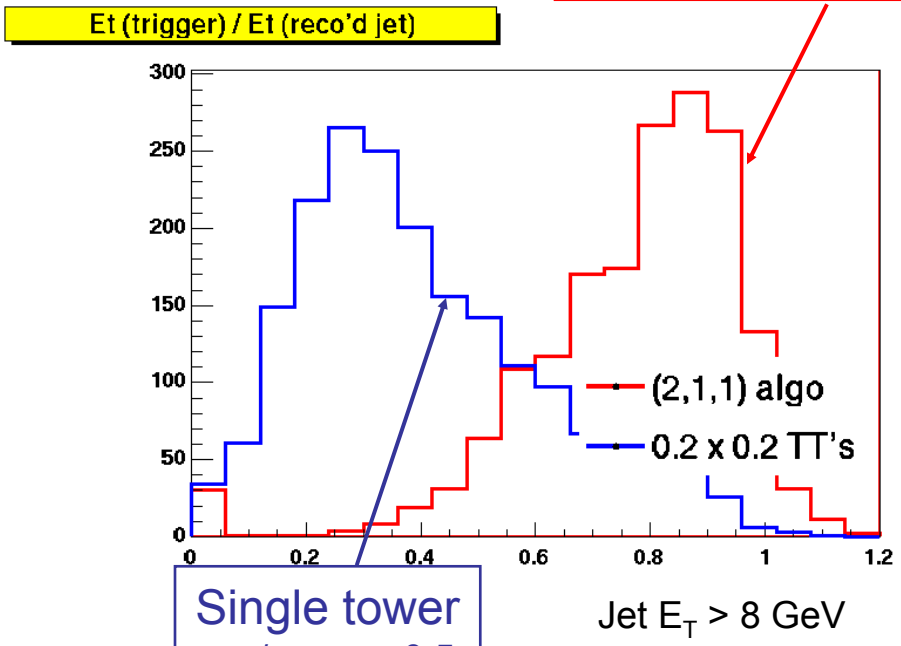
Object	**Outputs**	**Thresholds** (*i* = 1-7)
Jet	E_T EM+HD(4x4)	E_T > Jet Thr-i
Tau	E_T EM+HD(2x2) (uses R = EM+HD(2x2) / (4x4))	E_T & R vs Thr-i

Optimization of L1 Cal objects

The towers clustering of the **L1Cal Jet** objects leads to sharp trigger thresholds, which can be seen in the efficiencies of the new single jet trigger terms (later in the talk).

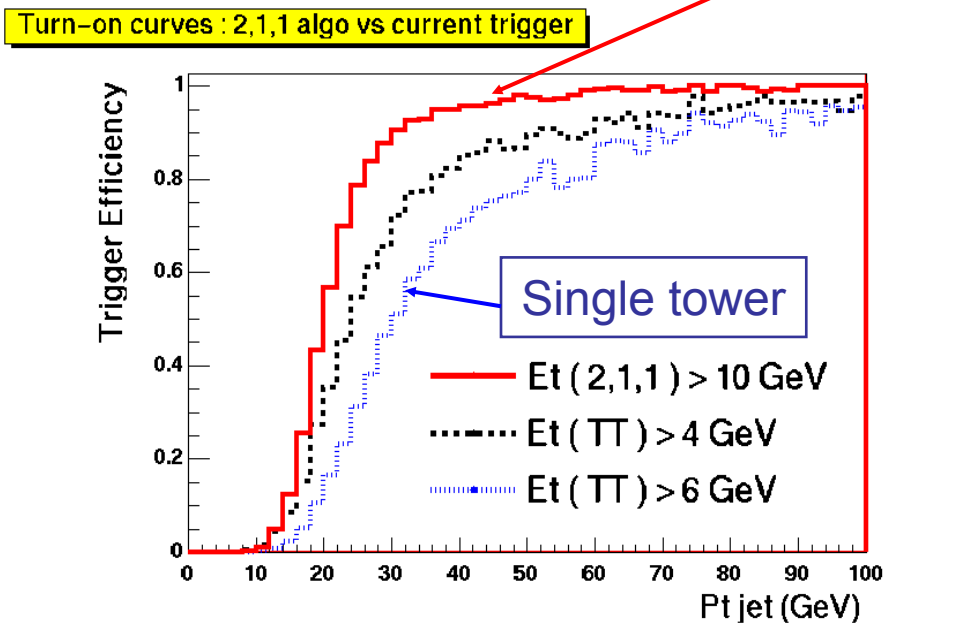
Run IIa data

Sliding window
rms/mean = 0.2



Single tower
rms/mean = 0.5

Sliding window

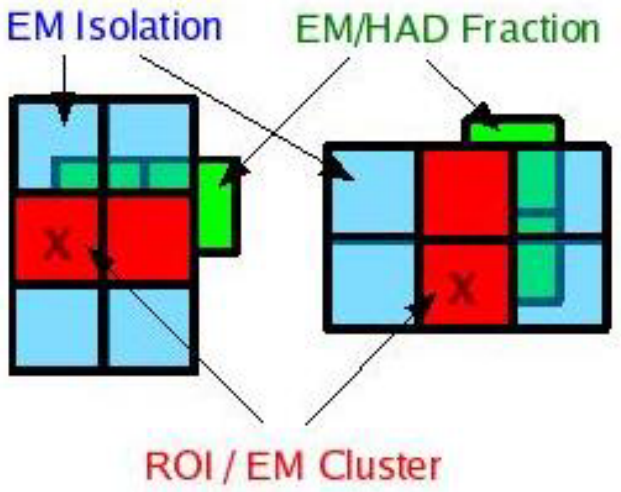


Optimization of L1 Cal objects

The **L1Cal Electron** objects have been recently re-optimized and are now final. During the optimization studies, tsim_l1cal2b and the trigger rate tool have been extensively cross-checked with each other.

Selected Algo:

- 2,0,1 Atlas-type of algorithm (1x2.or.2x1 RoI).
- Isolation is calculated using EM towers on either side of the RoI.
- EM/HAD fraction calculated using the 1x2 or 2x1 HAD towers directly behind a vertical or horizontal EM RoI.

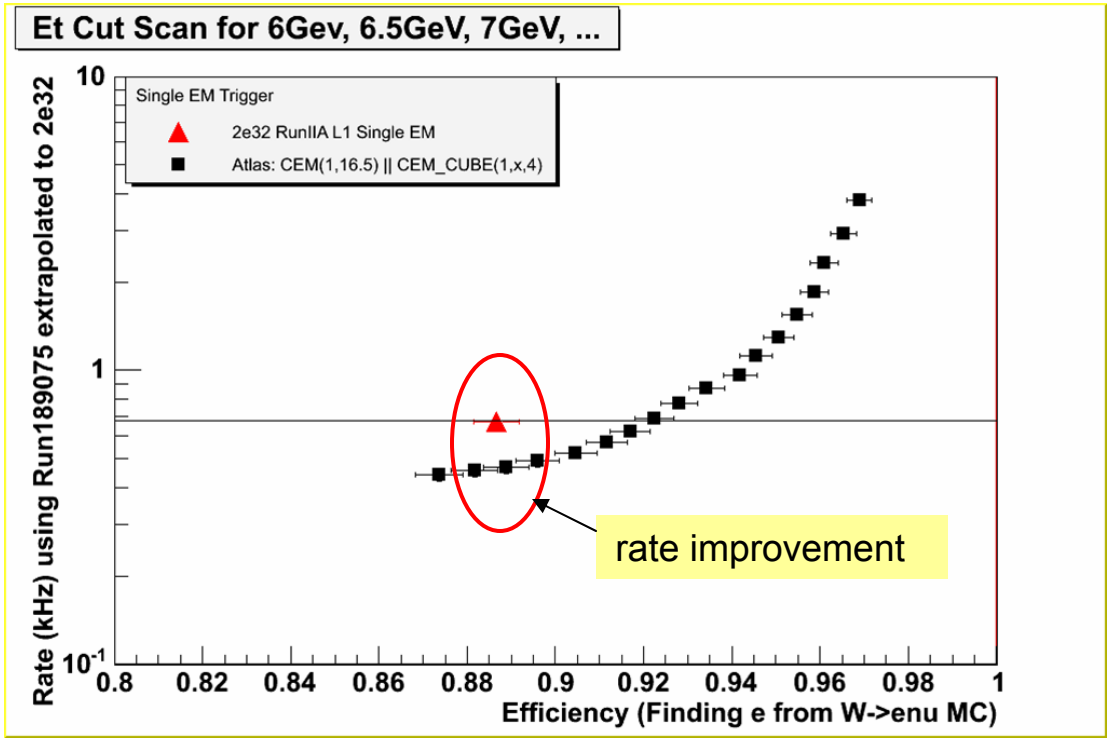


L1 Cal electron trigger studies

Comparison of rates and efficiencies. All rates extrapolated to 2E32.
Contact: Greg Pawloski, Rice University.

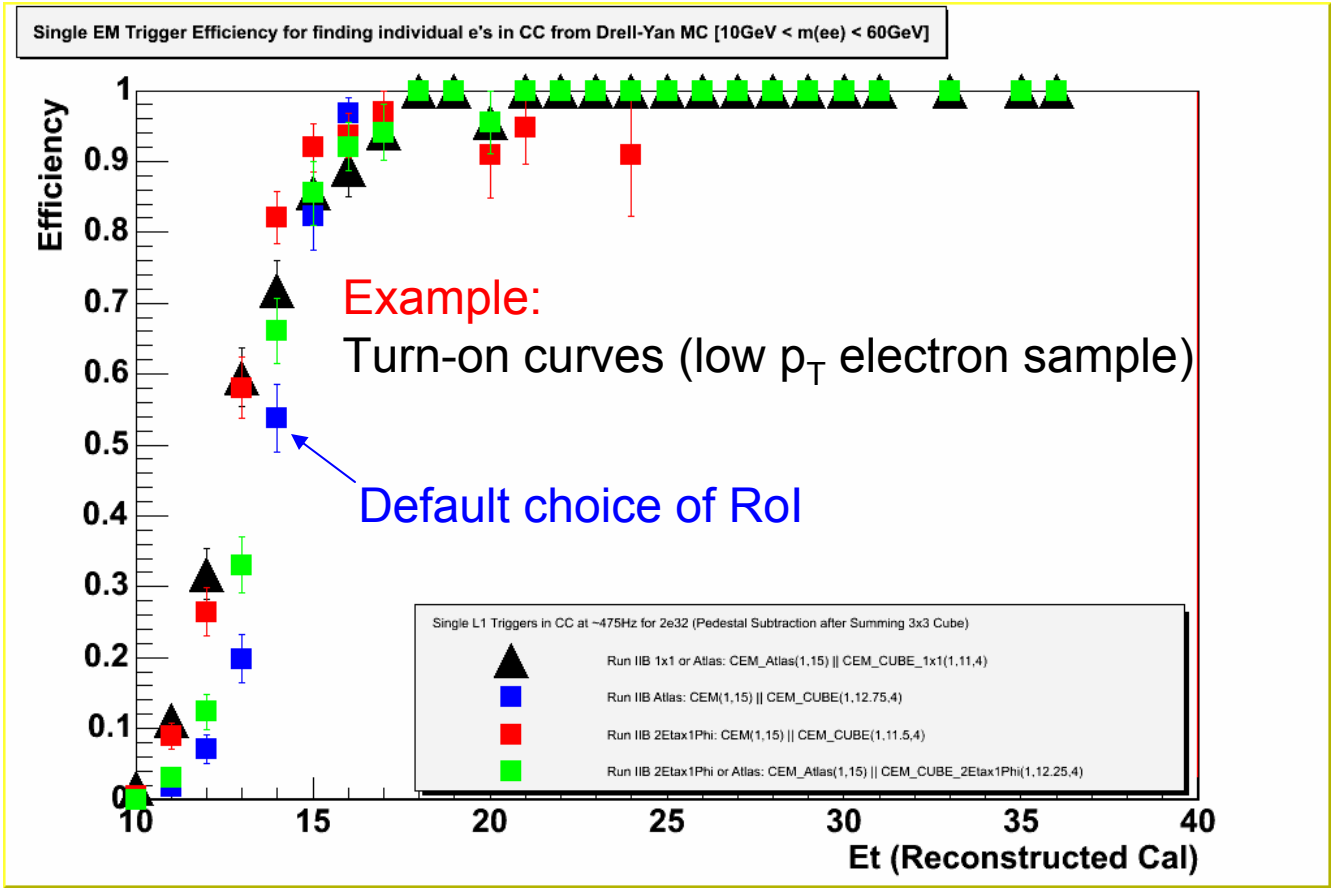
e.g. Single-electron triggers:

- L1 rate at 2e32 (from the rate tool) = 1417Hz
- Raise L1 IIa thresholds to saturate ½ such rate.
- Compare with L1 IIb Atlas algo (a 2x1 or 1x2 RoI proved to be the best choice).
- Rates from data. Efficiencies from MC.



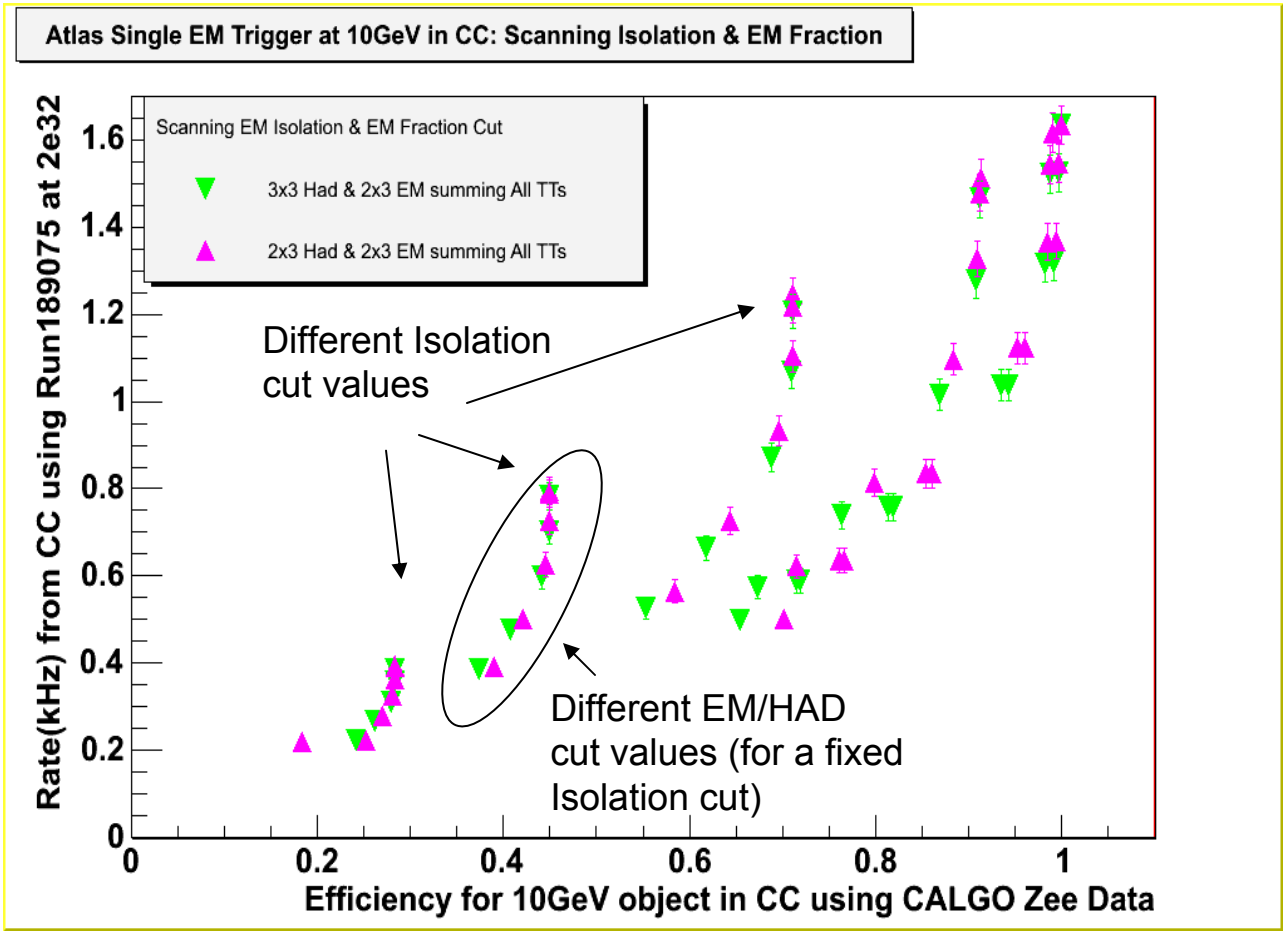
L1 Cal electron trigger studies

The comparison among different choices of IIb algorithms was performed on (non)isolated, high and low p_T electron samples, and for single electron and di-electron triggers.



L1 Cal electron trigger studies

The choice of Isolation and EM/HAD fraction definitions was fine tuned on Z→ee data.



Example:
Comparison of EM/HAD fraction choices.

- We select a 2x3 EM Isolation area and 2x1 Hadronic area for EM/HAD fraction (optimal also for non isolated objects).

Trigger menu studies

The trigger rate tool is useful for trigger menu studies, because it calculates the rates and overlaps of a complex series of trigger terms.
The first exercise, and a preparation for the IIb trigger list, is the “translation” of the latest physics trigger list (v13) terms into IIb terms.

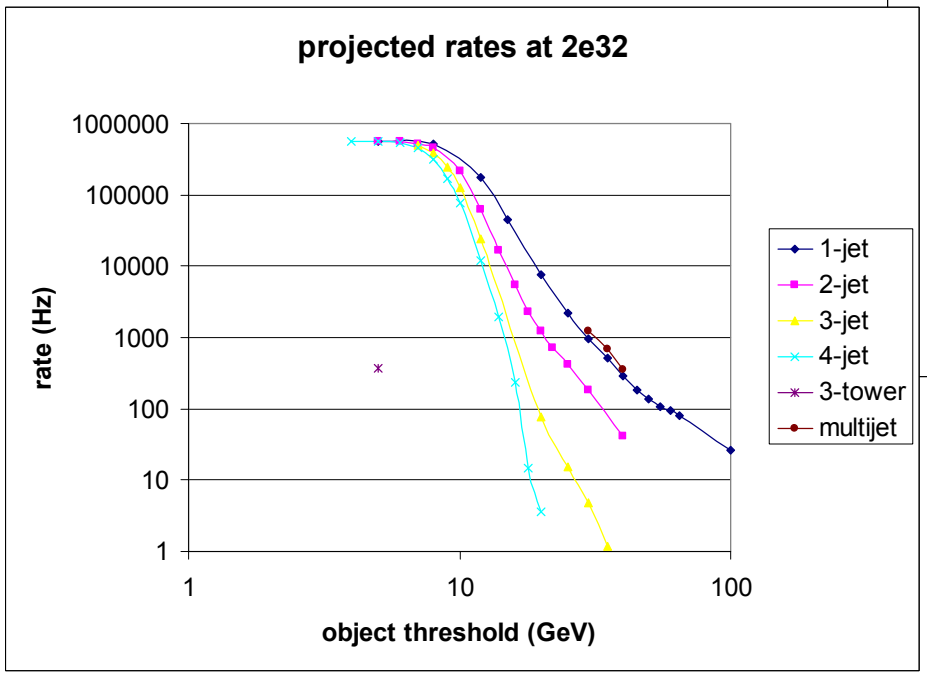
Example: L1 electron triggers	Rates (at 2E32):
CEMxEMfracAtlas(1,16.5,0,100) *(E_T>16.5 GeV, no EM/HAD, no isolation)* .OR. **CEMxEMfracAtlas(1,11,8,0.25)** *(E_T>11 GeV, EM/HAD > 8, isolation <0.25)*	**592 Hz**
DIEM_SW(6,8,0.25,0.0) *(E_T’s>6 GeV, EM/HAD > 8, isolation <0.25)*	**118 Hz**

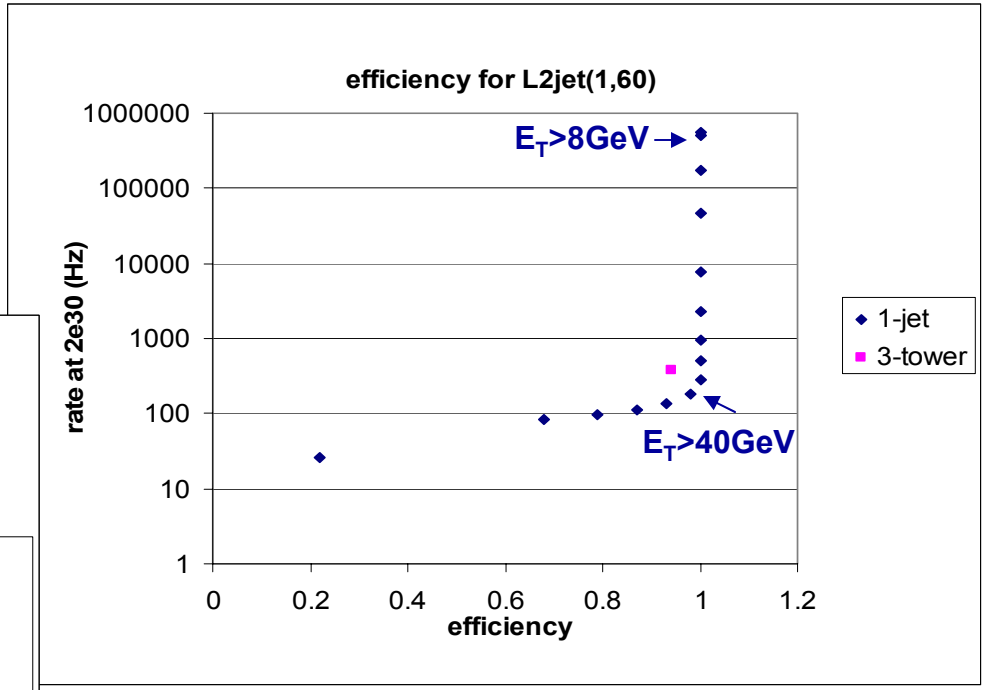
Compare with the IIa L1 EM.or. Rate (at 2E32) of 1.4kHz.

Trigger menu studies

Example: L1 jet triggers

- Mapping the rates for 1-,2-,3-,4-jet terms (all heavily prescaled in IIa, except for the E_T>125 GeV).





- Check rough efficiency with respect to L2Jet(n,x)
  → tune L2 thresholds.

Simulation manpower

Current manpower and responsibilities:

Level 3 project managers: Mike Hildreth (*U. of Notre Dame)*
Emanuela Barberis (*Northeastern U.)*
L1Cal simulator: Wendy Taylor (*York U.)*
L1CTT simulator: Carsten Hensel (*U. of Kansas)*
L1CalTrack simulator: Ken Johns, Charlie Armijo (*U. of Arizona)*

Trigger Rate Tool: Sabine Lammers (*Columbia U.)*

Trigger Studies: Greg Pawloski (*Rice U.*), Sabine Lammers and Hal Evans, (*Columbia U.*), Mike Hildreth *(U. of Notre Dame),* Emanuela Barberis and Darien Wood (*Northeastern U.*), Steven Beale (*York U.).*

L2Cal: Roger Moore (*U. of Alberta),* Bob Hirosky *(U. of Virginia),* MSU
L2STT: Junjie Zhu (*StonyBrook U.),* BU

Summary and Outlook

- Trigger simulator pieces well underway, first versions in place, aim at handing the completed executable to the Trigger Board in March, for trigger list optimization and verification by the Physics Groups.

- Trigger list studies under way, tools in place to estimate rates and efficiencies.

- Clear institutional responsibilities in the trigger simulation software, as well as in the hardware.

- More focus in the future in having IIb trigger studies reside in the Physics Groups (in addition to the project) and in tuning and expanding the L2 algorithms (Canada Consortium, U. of Virginia).

- Planning for installation and commissioning. Commissioning plans include comparison of data that will be collected in the L1Cal and the L1CTT systems with MC. Coordinating with N. Varelas.